HOUSEHOLD AND NATIONAL FOOD SECURITY IN SOUTHERN AFRICA

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FOREWORD

In 1985 the University of Zimbabwe and Michigan State University initiated a Food Security Research Network for Southern Africa. The objectives of the network are to conduct research that informs policymakers about food security issues and to help strengthen the regional capacity for food policy analyis. The underlying premise of the network is that building excellence in research capacity for national policy analysis comes through experience. In practice, this requires a long-term commitment to analytical capacity building, consistency in funding, and constant interaction between researchers and policymakers.

The network has sponsored four annual conferences for network researchers, policymakers, SADCC officials, and representative of international and donor agencies. The aim of the conference is to share research findings, identify new research themes, and provide an opportunity for policy dialogue between regional researchers, policymakers, and government officials.

The 1988 conference brought together 110 participants who deliberated on 28 papers. In the Official Opening, Vice-Chancellor W.J. Kamba of the Univesity of Zimbbawe highlighted the importance of including health related-issues as a component of food security; and Zimbabwe's Senior Minister of Finance, Economic Planning, and Development B.T.G. Chidzero outlined policy reform priorities for Southern Africa. Subsequent sessions focused on *SADCC's Food Security Programme, the Impact of Market Reform on Food Security, Food Security Policy Options, New Technology to Improve Food Security, Family Food Security Options in Low-Rainfall Areas, Expanding Agricultural Trade in the SADCC Region, Nutrition and Food Security, the Contribution of Small-Scale Rural Enterprises to Employment Generation and Food Security, and the Impact of Irrigation on Food Security.*

A highlight of the 1988 conference was the participation of five nutritionists from Zambia, Zimbabwe, Sweden, and the United States. The presence of the nutritionists stimulated formal and informal discussions on the food access side of the food security equation and drew attention to the need to initiate more research in this area.

A second highlight of the 1988 conference was the attention given to reducing barriers to expanded intraregional trade in the SADCC region. Results presented suggest that there appear to be substantial price and nonprice barriers to expanded trade. Nevertheless, there exist significant opportunities for expanding intraregional trade that can be realized through appropriate government initiatives.

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IRRIGATION AND FOOD SECURITY IN SWAZILAND: CURRENT STATUS AND RESEARCH PRIORITIES

Vincent M. Sithole and Jan Testerink[1]

INTRODUCTION

Swaziland is a small, landlocked country bordering the Republic of South Africa in the north, west and south, and Mozambique in the east. The country has four distinctive ecological zones, ranging for the wet highveld in the west with an elevation of over 2,000 metres to the dry lowveld in the east, with an average altitude of 100 metres. The population is currently about 676,000, growing at a high rate of 3.2% annually.

Agriculture is the main economic activity, providing a livelihood for more than 50,000 rural homesteads and serving as the basis for agro-industries. The striking characteristic of the rural economy is the division of land, where freehold tenure in the form of Title Deed Land (TDL) and communal tenure on Swazi Nation Land (SNL) exist side by side. The latter, about 60% of the total land, is held by the King in trust for the Swazi Nation, and provides a living for some 80% of the total population.

Some 850 farms and estates on TDL, with an average of about 800 ha, are technologically advanced, with about 60% of the arable land under irrigation. The main crops in this fully-commercialized sector are citrus fruits, sugarcane, cotton, and pineapples. By contrast, holdings on SNL which average less than 2 ha, employ a low level of technology and produce mainly maize. The contribution to the Gross Domestic Product (1981-1985) of crop production on TDL amounted to 14.6%; the contribution of SNL crop production was only 3.4% over the same period (Swaziland Government, 1988, p.6).

This paper deals with the contribution of irrigation to food security in Swaziland, defined in terms of both food availability and the ability to acquire food. Irrigation will thus be looked at in the light of food production, as well as providing employment to enable access to food. Finally, areas for further research will be identified.

STATUS OF IRRIGATION IN SWAZILAND

Organizational structure

The structure of irrigated farm operations largely follows the duality of the land tenure system in Swaziland, *viz.* those farms operating on Title Deed Land and those operating on Swazi Nation Land. For our purpose, we utilize the main subdivision

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in terms of the legal status of the land. We then include a third category, *viz.* repurchased Title Deed Land, now formally classified as SNL, but in practice these farms are managed and often operated by Tibiyo and/or Tisuka companies, and the holdings may be alienated, sold, or leased like TDL.

Much of the large-scale irrigation takes place on large TDL company estates, as well as on private TDL farms. SNL irrigation is generally small scale and often takes the form of a scheme, either cooperative or government run, or is run privately. The following subdivision can thus be made:

- o Title Deed Land involving companies and private irrigators;
- o Tibiyo/Tisuka Land; and
- o Swazi Nation Land involving government schemes, cooperative schemes, and private irrigators.

After briefly looking at each of these categories, the remainder of the paper will mainly deal with the third category, Swazi Nation Land.

Title Deed Land: companies and private irrigators

Company interest in establishing irrigation schemes dates back to the 1950s with the Commonwealth Development Corporation (CDC) setting up the Swaziland Irrigation Scheme in the northern part of the lowveld, with the main aim of producing sugar. CDC was followed by other multinational companies and a second large sugar irrigation scheme was set up in Big Bend with major involvement of Lonrho. Since the mid-1970s local capital was invested by Tibiyo, together with the Government of Swaziland and a "variety of overseas investors" (Swaziland Government, 1985, p.145). This resulted in the establishment of the Simunye Irrigation Scheme, again with the main focus on sugar, but also cotton is grown there under irrigation. About 80% of irrigated TDL are large estate farms--sugarcane and citrus being the predominant crops. Sugarcane is irrigated by means of overhead sprinklers, whereas flood, furrow, or trickle irrigation is applied to citrus.

It is not clear from national statistics how many private irrigators there are on TDL, but the literature clearly points at a substantial involvement of TDL farmers in irrigation, growing sugarcane, cotton, citrus, maize, and vegetables.

Tibiyo land

The main irrigation scheme on Tibiyo land is the Vuvulane Irrigated Farms (VIF) scheme. This scheme was set up in 1962 by the CDC as the smallholder component of the Inyoni Yami Swaziland Irrigation Scheme. The land, owned by the CDC, was leased to 263 farmers with plots ranging from 8-16 acres. The VIF was set up as a contract farming scheme, where the CDC provided overall management. The farmers receive credit and inputs and in return, they are obliged to keep at least 70% of their land under sugarcane. The remainder is mainly planted with vegetables. In 1983, the CDC formally handed over the VIF to the Swazi Nation, thus effectively changing the title to Swazi Nation Land.

Swazi Nation Land

In the documentation on irrigation in Swaziland, little detail is available on the distinction between government and cooperative irrigation schemes. However, in the *Agricultural Census* (1983-84) the distinction is made (Table 1). Comparing these figures with the 1978-79 growing season, it is clear that the number of homesteads with irrigation has grown considerably, from 3,895 in 1979 to 4,692 in 1984, or from 7.2% of all SNL homesteads to 8.9%. However, for 1979 no distinction was made between private and scheme irrigators. The majority of irrigators (90% in 1984) irrigate in their private capacity, whereas 3% of the irrigators are in government schemes and 7% are in cooperative schemes.

Government schemes. These schemes were designed and implemented by the government, free of charge to the farmers. Farmers were selected by the local chiefs, but no attempt was made to gauge interest or ability. This, according to Dunn (1984, p. 59), is the main reason these schemes are the least efficient.

According to Funnell (1984, p. 2), there are nine of these purely government operations within Rural Development Areas, and an additional three are donor assisted. The schemes range in size from 2.4 to 100 ha with a mean size of 18 ha; and they have an average of 20-24 farmers. These figures relate to the late 1970s and early 1980s. The *Agricultural Census 1983-84* found a total of only 142 farmers on eight government schemes (de Vletter, 1987 p. 4). Therefore, it appears that the number of participants per scheme has declined, which tallies with the observations made by Dunn (1984, p. 60) that "Absentee farmers are a serious problem on these schemes". However, De Vletter (1987, p. 4) reports from a survey carried out among a total of 22 irrigation schemes in operation in Swaziland (excluding the Vuvulane Irrigated Farms scheme) with a total of 558 members. As the total number of scheme farmers reported by the *Agricultural Census* was 470, the latter is probably underreporting.

Table 1. Irrigation on Swazi Nation Land, Swaziland, 1983-84 and 1978-79.

	1983-84		1978-79	
	Frequency	%	Frequency	%
Government schemes	142	0.3	na	na
Cooperative schemes	328	0.6	na	na
Private irrigators	4,222	8.0	na	na
Total irrigators	4,692	8.9	3,895	7.2
No irrigation	48,414	91.2	50,178	92.8
Total SNL homesteads	53,106	100.0	54,073	100.0

Source: 1980; CSO (1986).
na = data not available

Cooperative schemes. These schemes are initiated by interested farmers with partial funding, design, and development assistance from the government and sometimes from donor agencies. Management, labour, and most of the funding is provided by the farmers themselves through an association or cooperative.

On these schemes, crops are generally grown on individual plots and the individual farmer decides on the type of crop. Marketing of the output is also dealt with individually, but maintenance work on furrows, dams, sheds, etc. is done by work groups arranged by the scheme committee. Inputs like pesticides and fertilizers are often purchased in bulk by the cooperative. According to Dunn (1984, p. 60), the upkeep of this type of irrigation scheme is generally much better than on government schemes.

At present, there are 14 of these irrigation schemes (Vletter, 1987, p. 13). When we apply his figures to the Census figure of a total of 328 farmers in cooperative schemes, this means an average of about 23 members, a mean also mentioned by Funnell (1984, p. 2). According to the *Fourth National Development Plan 1983-84 to 1987-88 (p. 387),* these schemes cover a total area of 444 ha, but it is not indicated to which year this figure refers.

Private irrigators. Individually operated schemes are usually entirely financed and managed by the individual farmer. Therefore, farmer commitment and involvement is very good. Some of the farms get technical advice from the Ministry of Agriculture and Cooperatives' Irrigation Division, but these usually are the larger farms. According to the census figures, there is a total of 4,222 private irrigators, or almost 9% of all SNL homesteads.

Type of irrigation

From here on in this paper, it will not be possible to distinguish between different types of schemes. Data on the method of irrigation are scarce and the source used here is the Central Statistical Office's *Agricultural Census 1983-84,* which does not consistently make the distinction.

Table 2 gives details on irrigation methods. Forty percent of all irrigators use furrow irrigation, but this percentage is significantly higher among scheme irrigators (79%) than among private irrigators (36%). Sprinkler irrigation is more popular with scheme irrigators (7.7%); only 3.1% of the private irrigators use sprinklers. The majority of the private irrigators use buckets (57%).

Some socio-economic characteristics of irrigators

To put the role of irrigation in its proper socioeconomic context, it is useful to compare irrigators with nonirrigators and all Swazi Nation Land homesteads. Some socioeconomic data are available from the *1983-84 Agricultural Census.*

Irrigators have significantly more residents on the homestead than nonirrigators (9.4 vs 7.8 on average). Therefore, irrigators have more labour available than they can utilise for often labour-intensive irrigation practices.

Both scheme and private irrigators seem to be considerably better off than average SNL homesteads in general and nonirrigators in particular. Almost 47% of

Table 2. Method of irrigation, Swaziland, 1983-84 season.

Irrigation Method	Private irrigators		Scheme irrigators		All irrigators	
	Frequency	%	Frequency	%	Frequency	%
Furrow	1,506	35.7	371	78.9	1,877	40.0
Sprinkler	131	3.1	36	7.7	167	3.6
Bucket	2,393	56.7	50	10.6	2,443	52.1
Other	192	4.5	13	2.8	205	4.4
Total	4,222	100.0	470	100.0	4,692	100.0

Source: CSO (1986)

the nonirrigators own no cattle and 82% of the irrigators do own cattle, a common wealth indicator in a society where cattle holdings represent saving capability, as well as status.

In general, irrigators are more progressive in terms of agricultural practices. Almost 8% of all irrigators own a tractor; scheme irrigators score a high 12% here. Tractor ploughing is fairly common; more than one-third of the irrigators use a tractor to plough at least some fields; for the nonirrigators this is only one-quarter. Tractor ploughing on schemes is very high, probably because the scheme cooperative often operates its own tractor service. The availability of a span of plough oxen is also higher among irrigators, which means that for ploughing activities, irrigators are generally less reliant upon other farmers to plough their fields. In practice, this means that the time of ploughing can be chosen optimally.

Area under crops

Further analysis of data collected during the *Agricultural Census 1983-84* gives a fair picture of areas under different crops. The data used refers to SNL irrigators, irrespective of their organizational status, since no distinction was made by the Central Statistical Office between scheme and private irrigators. Furthermore, land measurements were made only for a sample of farmers.

The mean total cropped area per homestead is larger for irrigators than it is for nonirrigators; 1.8 ha vs 1.6 ha respectively; whereas, the mean area left fallow is the same, 0.1 ha per homestead. The 0.2 ha difference constitutes the irrigated area. In other words, the extra land available to these homesteads was put under irrigation. However, it must be kept in mind that this does not necessarily reflect an actual decision by the individual farmer, as we are presenting national means. The situation on individual farms may be quite different from this. Furthermore, the difference in size seems to be mainly due to the fact that there are more farmers in the category "more than 2 ha", the only category where the difference is significant (32.4% of irrigated farms vs 24.4% of the nonirrigated farms).

More than 80% of the farm areas is devoted to dryland maize, but there is hardly any maize under irrigation. Almost all irrigated land on SNL is under fruit and vegetables which account for 80% of the irrigated area. Most irrigated plots are

very small; almost 43% are less than 0.05 ha with a range from 5 square metres to 3.35 ha and a mean of 0.23 ha.

POLICIES AND DEVELOPMENT PLANS

Policies

The Government of Swaziland has committed itself "to promote increased crop production and reduce its seasonality by encouraging the use and number of irrigation schemes" (*Fourth National Development Plan*, p. 386). Two of the priorities of the section identified for the plan period are: to provide an intensive irrigation and horticultural advisory service" and "to encourage the expansion of areas under irrigation on individually operated schemes from 76 to 263 ha and on cooperative schemes from 444 to 1,000 ha".

Government schemes

Government-operated schemes are not mentioned in the list of priorities, but in another section of the plan, mention is made of rehabilitation of RDA irrigation schemes as proposed under an International Fund for Agricultural Development (IFAD) funded Smallholder Credit and Marketing Project. However, it is stated, that "experience to date indicates that there is first a need to restructure the schemes before additional expenditure is incurred. It must be ensured that only interested and committed farmers are involved, ... and that adequate extension support is available" (*ibid*, p. 155). On the same page, the plan emphasizes that only small-scale schemes are appropriate on SNL, "so as to be in congruence with the traditional system".

Nuclear estate model

In the same spirit, the plan endorses the Vuvulane Irrigated Farms nucleus/smallholder model, as part and parcel of estate schemes, when it notes that:

> given the need to improve the elasticity of employment and develop the country's irrigation potential in the most productive way, it is widely recognized that future agricultural development in the modern sector should concentrate on more labour intensive irrigation schemes on the nucleus/smallholder model.

The experience of Vuvulane is considered to provide a successful example in this respect (*ibid*, p. 145).

Thus, effectively suggesting a more direct involvement of smallholders in the estate-irrigation sector. However, the plan recognises that this sector is over-dependent on sugar. Therefore, it suggests that another cash crop would have to provide the foundation for other potential schemes and proposes that cotton may be a promising crop, given the good market prospects.

Large-scale schemes

This government standpoint opens the way for various development agencies and multinational corporations to initiate large-scale irrigation schemes, albeit with some smallholder component in the form of an outgrower or contract-farming scheme. This is not the place to review outgrower schemes[2], but it should be noted here that this type of scheme is problematic as it does not fit into the traditional system, where land and water are acquired free of charge. VIF went through a period of disputes relating to this problem, and no satisfactory solutions have as yet been found.

Swazi Nation Land

Turning to government policies relating to SNL irrigation, the Central Rural Development Board (CRDB) is charged with the responsibility of ensuring that irrigation development takes place in an orderly manner to prevent conflicts over resource use. As Funnell notes, "Traditional access to land and water under communal tenure provides a good starting point for vegetable producers, but the development of more elaborate arrangements means that the appropriate authorities ... must give their sanction. Water abstraction becomes more obvious when extensive furrows and diversions are constructed" (Funnell, 1985a p. 16). Water abstraction is controlled by law. For abstraction over 3,400 litres per day, a permit has to be obtained through the CRDB from the Water Apportionment Board. The water used by SNL irrigators is part of the general allocation to SNL and, although at present there is spare capacity, future expansion may result in conflicts between small irrigators and other developments.

Irrigation development plans

Development plans for further SNL irrigation schemes are heavily influenced by donor interests and experience. Two recently proposed irrigation programmes deserve mentioning here. The first one originates from the USAID Small Farmer Irrigation Project; the second one is proposing the rehabilitation of RDA irrigation schemes as part of the IFAD Smallholder Marketing and Credit Programme.

New smallholder schemes

The first project aimed at introducing irrigation into the farming system of SNL homesteads as a means of converting these primary subsistence farms into commercial ventures (Funnell, 1984, p. 12). A total of US$7.2 million would be made available over a five-year period. Included in the proposal was the development of 15 new irrigation schemes, five of which would be about 40 ha each, the remainder about 12 ha each, introducing a total of approximately 350 farmers to irrigation. Farmers were expected to submit plans to the Ministry's Irrigation Section, thus following the established pattern of small-scale irrigation development.

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[2]For a critical discussion of contract farming in Swaziland, see Neocosmos and Testerink (1985), in which it is shown that to a large extent, the outgrowers are at the mercy of the multinational corporation running the scheme.

However, this project did not reach the stage of implementation and according to de Vletter (1987, p. 6) "Lack of government commitment to the project is said to be behind its ultimate demise".

Rehabilitation of RDA irrigation schemes

The IFAD programme proposes to complement the USAID schemes, and funds are made available to rehabilitate 12 RDA irrigation schemes. As noted above, the government has not received this proposal with great enthusiasm; but the project is being implemented and at present the Ministry of Agriculture and Cooperatives is negotiating to extend the number of schemes to be upgraded. The main thrust of the IFAD proposal lies in improving marketing services. A central market with cooling facilities was built in Nokwane near Manzini last year, and this could obviously have important effects on irrigated vegetable production. Furthermore, the IFAD credit scheme will materially assist (among others) irrigating farmers.

Usutu and Ngwavuma River Basin Project

Two large-scale TDL/Tibiyo land-based schemes, employing the nucleus/smallholder model, have been proposed and feasibility studies carried out. One of these is the Usutu and Ngwavuma River Basins Project, for which a feasibility study was undertaken by Tate & Lyle consultants in 1982, commissioned by Tibiyo. The study proposes the development of seven irrigation development units within the catchment areas, covering a total of 35,000 ha, to be implemented over a 20-year period. On full development after 30 years, a total of 4,410 smallholders were projected to have been settled; a total permanent employment of 7,470 was foreseen, as well as a seasonal employment of 39,680.

Komati Basin Project

A second proposal for a large-scale irrigation project is the Komati Basin Project, for which a feasibility study was carried out by Devres in 1985. A smallholder/nucleus estate irrigation project, covering 3,000-5,000 ha is proposed. On the 3,000 ha alternative, 1,200 ha would be set aside for a total of 600 smallholders. The 5,000 ha option would allocate 2,000 ha to 1,000 families. The scheme would employ a total of 927 full-time farm workers and 627 part-timers under the first alternative, and 1,545 and 1,045 workers, respectively, in the bigger set-up (Devres, 1985). However, after careful consideration, the Ministry of Agriculture and Cooperatives decided that the plans were unrealistic. A further feasibility study was proposed that will be undertaken in the near future.

More recently, three additional projects have come under consideration, *viz.* a European Development Fund (EDF) supported rehabilitation scheme, and the Ngwempisi and Nyonyane schemes.

AGRICULTURAL PRODUCTION AND FOOD SUPPLIES

Government has introduced improved farming techniques to SNL farmers through programmes such as the Rural Development Areas Programme (RDAP). While this

has resulted in increases in crop yields, such programmes fall short of increasing the yields to their greatest potential because of the failure to solve the problem of unreliable rainfall.

The rainfed agricultural system leaves the country susceptible to drought. Available statistics show stagnant maize production over the years, as well as a general increase in imports. The proportion of food imports in the country's total imports is low, averaging 8.6% for the period 1981-86.

Fluctuations in production are enormous, ranging from 30,000 mt of maize in 1982-83 to 170,000 mt in 1984-85. Vegetables are mainly produced under irrigation. In the early 1980s when vegetable imports were banned, local prices and vegetable production increased. Today, the bulk of vegetable production comes from the modern subsector, including Vuvulane Irrigated Farms. During 1979-80 and 1982-83 when local production was insufficient to meet demand, a large amount of vegetables had to be imported.

The introduction of the Nokwane central fresh fruit and vegetable market in 1987 encourages local production by providing a guaranteed and readily available market for vegetables. Although it is too early to judge this market's performance, there are already indications that it is failing to find buyers for the vegetables. The above analysis shows that the rainfed agricultural system is subjected to drought. The need for water control is high if stable yields are to be attained.

FARM AND NONFARM EMPLOYMENT

Importance of wage employment

Russell and Ntshingila's study of the Central Rural Development Area shows that income from wage employment (from both residents and absentees) accounts for 69.5% of the homestead income. Agricultural enterprises contribute 13.5%, while livestock accounts for 4.7% (Russell and Ntshingila, 1984, p. 9).

Studies on African farming have shown that labour demand in rainfed agriculture is highly seasonal. For any crop, labour use is concentrated in peak periods of relatively short duration. This pattern of labour absorption in agriculture creates a need for off-farm employment, which often involves seasonal migration--either to urban or to other rural areas. Furthermore, seasonal agricultural work must compete for labour with nonseasonal jobs in urban areas, mining, and industry. This seasonal labour demand pattern contributes to the withdrawal of labour from agriculture.

Lack of adequate employment opportunities is one of the main development problems facing Swaziland. In 1987, the number of paid employees in a population of 676,000 was 95,000. That year had relatively good employment figures and represented a decrease in retrenchments from 2,200 in 1985-86 to only 340 in 1987, and most employment opportunities were created in the private sector. Despite these improvements in the domestic labour market during the last two years, they are insufficient to meet the demand for paid employment. There is an estimated average increase of 4,100 people per year seeking formal sector employment, but not finding it.

Given the economic sanction threat to South Africa, the mines which offered good employment opportunities can no longer be safely relied upon to continue this service to Swazi labour. There is a need not only to increase formal employment, but also to increase informal employment opportunities in the country.

Conflict between labour needs for rainfed vs irrigated farming

A consensus of opinion supports the notion that farmers are willing to concentrate full time on irrigated cropping. According to Funnell (1984, p. 3), this is justified, from an individual's viewpoint, because it may represent an optimal use of time and labour.

The question that can be raised is whether there will be a conflict over labour needs on rainfed crops. Irrigation requires an increased labour input. Given that it is mainly women who are available to work on farms on SNL, due to the high engagement of men off-farm, there may be a limit to the availability of labour. Women are already engaged in a range of activities; as the mainstay of the homestead on a day-to-day basis, as those who bear children, fetch water and fuelwood, work in the fields, and earn money through handicrafts and services such as brewing. However, irrigation can be utilized to spread on-farm labour demand as crops are produced not seasonally, but throughout the year. Provision of income earning opportunities, if made available, may require that women be freed from time-consuming but essential tasks before they can take them up.

Forward and backward linkages

Irrigated farming will likely have economic backward and forward linkages. Backward linkages will take the form of creating and/or increasing business activities for those dealing in farm inputs. To the extreme we could expect, for instance, the revival of the defunct chemical industry to supply chemical fertilizer and other agricultural chemicals. This would create employment and increase incomes.

Forward linkages will occur if irrigation leads to cash cropping, which no doubt would be the case as the cost of setting up an irrigation system may have to be justified by producing for a market. This production of crops for sale will promote agro-industries. In the case of Swaziland, the canned fruit and sugar industries provide good examples.

The sugar industry, composed of three sugar mills, depends on sugarcane as an input. Sugar is the "King" in the Swazi economy today, in terms of its contribution to foreign exchange: its share in total exports over the period 1981-86 was 37.1%. In addition, it is estimated that about 14% of the population is wholly or partly dependent on employment in the sugar industry.

The canned fruit industry relies on pineapple and citrus fruits produced by farmers (both on large scale and small scale). This industry contributes 5.6% of the country's foreign exchange earnings. In addition, the cannery is the country's largest single employer of women. In 1988, the cannery had a labour force of 3,949, a great proportion of these being women.

Increased crop production, due to improved yields stemming from water control and crop production throughout the year, can be expected to encourage the

establishment of more agro-industries to process the output. This, coupled with the good investment incentives offered in the country, will lead to increased employment opportunities and increased standard of living. As food insecurity at the individual level is usually caused by a lack of purchasing power, irrigation would thus contribute to increasing the degree of self-sufficiency.

SUGGESTED AREAS OF RESEARCH

The above analysis clearly suggests that there is need for research into the manner in which irrigation can best contribute to increased food supplies, as well as improved access of people to food supplies. Below is a list of suggested areas of research with brief explanations, leaving the details of each to be decided on at a later stage.

- There is need to update the existing data on irrigation, *viz.* types of irrigation, irrigated crops, and areas under irrigation. In the process of updating this, data should be extended to fill up gaps of missing information, such as a clear breakdown on production figures on irrigated crops and information on the nutritional status of irrigators vs nonirrigators.
- There is need to investigate the household-level decision-making process on land allocation to irrigation and dryland farming. The aim is to identify the factors taken into consideration when such a decision is made.
- Tied with this is the need to understand the employment history of the initiators of irrigation in the homestead. To what extent, for example, has income accumulated from off-farm employment been utilized to start irrigation? Also, the homestead development cycle of irrigators needs to be studied.
- Although irrigation may generally require higher labour input than rainfed agriculture, there is need to investigate the labour demand and use pattern under irrigation. Given the coexistence of irrigation with dryland farming, an investigation into possible conflicts on labour demand of the two systems is in order. Closely tied to this is the need to investigate the extent of conflict between female labour demand on the irrigated crops and their other numerous homestead tasks. The exercise calls for a monitoring study on labour use, carried out through visits of selected irrigated farms at least once a week.
- The impact of irrigation on employment creation also needs attention. The hypothesis that irrigation will increase labour demand--which homestead membership may fall short of providing, resulting in increased demand for hired labour, which in turn increases employment opportunities and incomes, and consequently increases access of people to food supplies--needs to be fully investigated.
- There is need to investigate, at the homestead level, the contribution irrigation will make to total farm income, as well as total homestead income--both in terms of crop sales and production for own consumption. In this

context, control over income and income distribution within the homestead also has to be studied.

- o There is need to assess the sources and magnitude of information on irrigation (both technical and on marketing) available to farmers, (*i.e.*, the impact of government and nongovernment agencies in providing information and equipment).
- o A farmer using irrigation may be seen to be interfering with water use in his community, especially on SNL where there is limited access to piped water. Thus, there is need to investigate the existence and extent of such conflicts.
- o A study on the potential irrigable land in the country should be undertaken by looking at the availability of physical resources in terms of soil moisture budgets, soils (texture, depth, soil permeability, etc.), salinity and alkalinity limitations, and topographic factors (including erosion and drainage limitations) in the different ecological zones.
- o Once the necessary data is collected, linear programming should be used to identify a crop mix that maximizes returns to farmers, taking into consideration the coexistence of irrigation and rainfed agriculture. Different crop mix for different areas and different types of irrigation should be identified.

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